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Mtonga, Elvis

University of Cape Town

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The real exchange rate of the rand and competitiveness of South Africa's trade

Elvis Mtonga¹
School of Economics, University of Cape Town

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Abstract

In the last 10 years since South Africa transformed into a democracy, the rand has seen an increase in volatility of its real exchange rate. These fluctuations in the rand's real exchange rate have raised questions as to whether they signify significant misalignment of the currency and thereby undermine competitiveness of South Africa's exports abroad. This is a pertinent question in the South African context because foreign trade has been critical to the growth of the economy. Efforts to address current high levels of unemployment and widespread poverty among the majority of the population have depended upon this growth. This study investigates the extent to which fluctuations in the rand's real exchange rate have impacted on the competitiveness of South African trade flows by determining whether, at some point, the rand had been misaligned, and the likely consequences of such a misalignment. Using data from 1972 to 2003, and an equilibrium correction model of the rand's real exchange rate drawn on existing literature, the study finds that, from 1994 to 1996, and also in 1998, the rand's real exchange rate became undervalued by an average 10%. By early 2002, the extent of overshooting had reached 20%. However, the strong recovery of the rand at the start of 2002 reversed this overshooting and instead pushed the real exchange rate above its equilibrium by an average 16 to 17% at the end of 2003. This suggests significant loss of trade competitiveness during 2003 and needed a nominal depreciation to correct the imbalance.

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1 Introduction

Managing the exchange rate has remained at the centre of South Africa's efforts to achieving and maintaining both macroeconomic stability and a sustained increase in the growth rate of the economy, ever since the country transformed to democracy in 1994. In this period, the problem of high and rising unemployment, combined with widespread poverty, emerged as the most pressing challenge facing the economy, mainly because of the country's history of segregation under Apartheid. Economic policy responses to this unemployment challenge have aimed at attaining a sustainable growth rate of the economy, which is seen by the government as a basis for job creation. However, the growth performance of the South African economy has proved insufficient to address the unemployment problem, with the country experiencing a contraction in output for the most part of the early 1990's, going by the growth in real gross domestic product per capita, which accounts for population growth in measuring the growth rate an economy. Though a rebound in economic growth has occurred since the mid-1990s, this has been too low, peaking just above 2% only in 1996, 2003, and 2004.

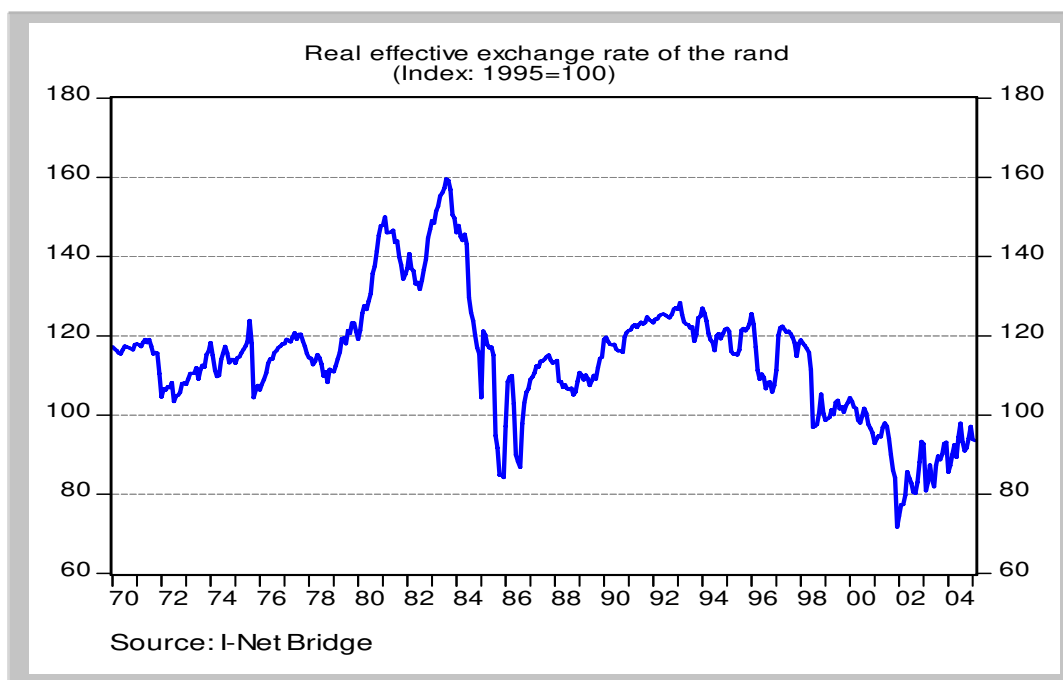
As the South African economy is highly dependent on the global economy, foreign trade has been critical to growth of the economy². Stability of the real exchange rate is thus seen by the Government as key to attainment of its growth objectives, since this not only impacts on global and domestic demand for South Africa's production but on domestic prices also. Being a relative price of domestically produced goods relative to foreign goods, the real exchange rate provides a measure of how much, on average, the cost of South African produced goods and services will cost relative to a comparable basket of foreign produced goods and services, and therefore of their competitiveness overtime. More so that exports reflect foreign demand of South Africa's production, their increase means that all output, employment, and incomes associated with their production may increase overtime and thereby contribute to the growth rate of the

² Foreign trade flows now account for more than 30 percent of Gross Domestic Product

economy. Unwarranted fluctuations in the real exchange rate, thus, tend to be detrimental to the competitiveness of exports. As such, the Government's growth and employment objectives may be undermined.

However, the rand's real exchange rate has experienced considerable volatility. As is evident in figure 1-1, which depicts the evolution of the rand's real effective exchange rate from 1970 through to 2005, fluctuations in the real exchange rate have, at times, been large and persistent for several months. After appreciating strongly in the 1970s by 50 percent from 1972 to 1983, the rand collapsed in the early 1980s by 47 percent over a space of just two years between 1983 and 1985. Subsequently, the rand rebounded by 44 percent between 1985 and 1994, but weakened again by 41 percent between 1994 and 2001. By December 2003, the level of the real effective exchange rate index represented an appreciation of more than 50% over its December 2001 level.

Figure 1-1: Real Effective Exchange Rate for the rand: 1970 to 2005



These fluctuations in the rand's real exchange rate have raised questions as to whether they indicate misalignment of the currency. The real exchange rate is,

conventionally, regarded as misaligned when its observed values exhibit persistent departures from its long run equilibrium trend, which is the value consistent with long run trends in economic fundamentals (IMF, 1998). In consequence, a misaligned real exchange rate is labelled “overvalued” when its value is higher (appreciates more) than its long run equilibrium value, and “undervalued” once it falls (depreciates) below the equilibrium value. Thus, to make an assessment of real exchange rate misalignment, a measure of the equilibrium real exchange rate is often required as this forms a benchmark against which the actual or observed real exchange rate can be gauged (Maeso-Fernandez, et al, 2001).

This question of whether or otherwise the rand’s real exchange has, at any point in time, been misaligned is pertinent to South Africa given, as already noted, the importance to the economy of foreign trade and capital flows. In such an environment of greater openness of the economy, misaligned real exchange rates are known to have the potential to impose large costs to the economy, in the sense of having an adverse effect on resource allocation in the economy. When a country’s real exchange is overvalued, the implication is that domestic goods become more expensive relative to foreign goods, since it reflects the price of domestic goods relative to foreign goods. This has the potential of increasing the demand for foreign goods at the expense of domestically produced goods, and as a result, there will be considerable scope for imports to increase, while the production of domestically produced import substitutes is more likely to decline. Because of the increase in the cost of producing them, and the associated loss of profitability, exports will be harmed. Thus, overtime, a country’s external position will tend to deteriorate, and rising unemployment may accompany this.

On the other hand, a “real undervaluation means that domestic goods are becoming cheaper relative to foreign goods, thereby making them more competitive. As a result of the likely shift in demand in favour of domestic goods, there will be opportunities to increase the production of domestic import substitutes, thereby giving rise to a situation of a faster growth of exports. The growth of imports will also tend to slow down and,

overtime, there will be tendency for country's balance of payments to improve, as well as the employment situation.

The adverse effects of real exchange rate misalignment are, thus, well recognized in the literature. However, the significance of these often different and complex effects of changes in the real exchange rate will, in many instances, depend of the economic conditions prevailing in the country, such as whether the economy is in recession or boom (De Kock Commission of Enquiry, 1985). Much also depends on the prevailing stance of other policies, such as fiscal and monetary policies, which may strengthen or weaken the transmission of these exchange rate effects to rest of the economy. While this may seem to suggest that the adverse impacts of real exchange rate misalignment are not automatic, an understanding of the extent of real misalignment is nonetheless important, as if such misalignments were to be large, this may serve to suggest the likely costs that the economy is likely to face in the future, if no adjustments to domestic policies are made.

Thus, we investigate, in this study, the extent to which past movements of the real exchange rate of the rand have impacted on the competitiveness of the South African trade flows by determining whether at some point the rand had been "misaligned" or otherwise, and the likely consequences of such a misalignment. Because "misalignment" is with reference to some benchmark equilibrium measure, we identify the variables that are fundamental in valuing the rand, which we then use to estimate a long run model of the rand's real exchange rate. Based on the findings of the long run real exchange rate model, we derive a long run equilibrium real exchange rate value for the rand, which we compare with the observed real exchange rate so as to make judgment on whether or not the rand has been "misaligned".

There already exist other studies that have empirically examined the determinants of the rand's real exchange rates and their implied misalignments. Aron, Elbadawi and Khan (1997, 2000) tested for long run determinants of the rand's real exchange using data for the period 1970 to 1995 and found the terms of trade, the gold price, official reserves, government expenditure, long term capital flows, and degree of trade

restrictions to have been the main determinants. However, the study did not probe the issue misalignment in the real exchange rate. Using data from 1970 to 2002 and a somewhat smaller set of explanatory variables, MacDonald and Ricci (2003) also estimated an equilibrium real exchange rate model for the rand, which they used to measure the degree of misalignment. Their analysis showed that, in early 2002, the rand had overshoot its equilibrium value by at least 25%. Similarly, Samson et al (2003a, b) found that the rand's real exchange rate had become significantly undervalued in 2002, following a prolonged period of considerable depreciations during 2001. Previous studies are thus confirmatory of the important of economic fundamentals in providing useful information to understanding movements in the rand's real exchange rates.

Our study adds to this literature in two ways. Firstly, we test for the significance of additional variables and employ a somewhat different specification. Secondly, we use a large sample and test our model across two different sample periods.

In terms of organisation, the rest of the discussion has been structured as follows. Section 2 examines the literature on the analytical and methodological framework connected with estimation of equilibrium real exchange rates and assessment of real exchange rate misalignment. Next, in section 3, we discuss the empirical approach adopted by the study, beginning first with a discussion of the theoretical model, and then the econometric methodology used to analyze the relationship between the real exchange rate and a set of economic fundamentals considered and the empirical results. Finally, we conclude the discussion, in section 4, with a presentation of a summary of main findings.

2 Methods for assessing real exchange rate misalignments

Even though, conceptually, real exchange rates can be precisely defined as prices of home goods relative to foreign goods, their empirical examination poses challenges. The basic problem is that these international pricing relationships are practically

unobservable and have to be calculated based on an analytical framework³. This poses the difficult that, in the literature, one finds multiple analytical frameworks, which give rise to different empirical values for the real exchange rate to choose from.

On one hand, economists have focused on the so called *external real exchange rate*, which is derived as a ratio of the home to the foreign value of a broad based price index, where both prices are denoted in the same currency (Hinkle & Montiel, 1999). However, matters are complicated by the fact that there exist multiple price indices to choose from, with the implication that there are as many empirical real exchange rates as there are price indices (Mark, 2001). On the other hand, the real exchange rate has been defined as a relative price of tradable goods in terms of non-tradable goods, and this is labelled the *internal real exchange rate* (Hinkle & Montiel, 1999). Even with this approach, multiplicity of conceptual definitions give rise to several estimates of the real exchange rate, thus raising the question as to when it might be appropriate to use one rather than the other. Nonetheless, subject to these conceptual and empirical ambiguities, three alternative methods have been widely used to assess misalignments in real exchange rates.

2.1 The purchasing power parity approach

The purchasing power parity (PPP) approach is the basic methodological framework often used for the empirical examination of real exchange misalignments. This approach is based on the law of one price, which holds that if markets are competitive and there is free trade of goods between them, the same basket of goods and services should command the same price across all markets when expressed in a common currency. To the extent that the law of one price held true, the implication is that the nominal exchange rate that ensures convergence of prices of a common basket of goods and services between two countries constitutes an equilibrium value for the nominal exchange rate, which is labelled the PPP-exchange rate (Clark, et al, 1994).

³ See Hinkle and Montiel (1999) for a more detailed discussion of this

If for some reason the market exchange rate significantly differed from the PPP-exchange rate, then profits can be made by buying the common basket of goods in the low price market and selling it in the high price market, a situation that will eventually tend to push the exchange rate back to its PPP equilibrium value overtime. In consequence, PPP predicts that the real exchange rate remains unchanged overtime, starting from a position of equilibrium in a base year when a country's balance of payments position was judged to be sustainable (International Monetary Fund, 1998). Assessing real exchange rate misalignment under the purchasing power parity approach then involves a comparison of prices of a basket of goods produced by the home country with that of a comparable basket abroad and calculating the exchange rate that would equalize them, relative to a base year in which the balance of payments was judged to be sustainable (Wren-Lewis, 2003). If its current rate is higher or lower relative to its level in that base year, then the real exchange rate is misaligned.

However, as is also evident in figure 1-1, the volatility in real exchange rates has cast doubts over the validity of the purchasing power parity approach. More often researchers have empirically observed large and persistent fluctuations in real exchange rates since the advent of free floating exchange rate regimes in 1973, for example, Isard (1995). Other evidence against the purchasing power parity approach has come from a large empirical literature testing its validity, which finds the approach an empirical failure and that deviations of real exchange rates from their implied PPP values take an average 4 years to be reduced by half (see Froot & Rogoff, 1995). These empirical observations of large and persistent deviations in real exchange rates have been taken as a suggestion that other factors may be at play, particularly in the short and medium run periods, which the approach ignores, as attention is focused only on price and inflation differentials. Consequently, consensus has emerged in the economic literature that the purchasing power parity approach is not adequate to measure and estimate equilibrium real exchange rates. At best, the approach provides only a partial approximation of equilibrium real exchange rates, and therefore, of the extent of their misalignments.

2.2 The macroeconomic balance approach

The empirical criticisms of the purchasing power parity approach discussed above have led Williamson (1985, 1994a, b) and Isard and Faruquee (1998) to advocate the macroeconomic balance approach to assessing misalignments in real exchange rates⁴. This entails calculating the equilibrium real exchange rate as the rate that simultaneously yields the economy's internal and external equilibrium. External equilibrium is taken to mean achievement of a sustainable current account deficit, meaning one that can be financed without undue foreign borrowing or an unnecessary loss of foreign reserves (International Monetary Fund, 1998). Internal balance, on the other hand, is defined as the level of output corresponding to full employment and low inflation or macroeconomic stability. As the equilibrium real exchange rate depends on internal and external balance, it will change once this position changes. The equilibrium exchange rate is, therefore, thought of as a range of equilibrium exchange rates rather than a single number and changes overtime consistent with fluctuation of its fundamental determinants (International Monetary Fund Institute, 1998).

In addition, the approach incorporates explicitly the time horizon in its notion of equilibrium. This implies that the real exchange rate should be considered to be in equilibrium only in the context of economic fundamentals determining internal and external equilibrium over a given time frame (Hinkle & Montiel, 1999). This follows because economic fundamentals that may be relevant for achievement of internal and external equilibrium at say a short run period may differ from those ones with the most influence over a much longer time horizon. Thus, in practical applications, researchers often select a different set of economic fundamentals defining both internal and external equilibrium, and therefore a different value for the exchange rate, depending on the time horizon under investigation (Clark et al, 1994). In this respect, the macroeconomic balance represents a major advance over the purchasing power parity approach.

⁴ For an extensive discussion of this approach, see Clark et al (1994) and Isard and Faruquee (1998)

However, it has its drawbacks also. One is that the approach is a method for calculating equilibrium real exchange rates, rather than a theory of exchange rate determination and does not therefore embody theoretically testable predictions. The other relates to the fact that though the macroeconomic balance provides a precise description of internal and external equilibrium, and therefore of the equilibrium real exchange rate, this is difficult to determine in practice. When exactly an economy's macroeconomic equilibrium prevails in practice can not be easily discerned. For this, one would require a macroeconomic model that accurately captures relationships defining current account balance, full employment level of output, and inflation. But, the practicality of constructing such a model is often hampered by resource constraints.

Thus, in empirical applications, researchers have attempted to overcome the latter problem by employing theoretical models designed to seek a set of economic relationships describing an economy's output and balance of payments position, and where the value of underlying determinants have been set at their full employment or sustained levels (Clark & MacDonald, 1998). The real exchange rate calculated from such an exercise is labelled the "fundamental equilibrium exchange rate" (FEER), reflecting the emphasis on fact that only those factors judged to be important over the medium to long term period should be considered in its derivation, abstracting from transitory factors.

Applying this approach, some researchers have used large econometric models⁵, for example, Williamson (1994b), who used several macroeconomic models to estimate equilibrium real exchange rates for currencies of the major industrial countries in the 1990s. His analysis revealed significant deviations of real exchange rates from their implied equilibrium values. So too did Bayoumi et al (1994), Faruqee et al (1996), Wren-Lewis and Driver (1997), Wren-Lewis (2003), and Rosenberg (2003). Other researchers have applied relatively small theoretical models, using empirical estimates of underlying parameters to establish the relationship among output, the balance of payments position,

⁵ Clark et al (1994) and Clark and McDonald (1998) survey many of these studies

and the real exchange rate. An example is Stein (1995) who calculated equilibrium real exchange rates by estimating regression models of the real exchange rate with several macroeconomic variables. Infact, most studies employing the macroeconomic balance approach have focused on industrial countries.

2.3 The behavioural equilibrium exchange rate (BEER) approach

Finally, a more recent method is the behavioural equilibrium exchange rate (BEER) approach. Pioneered in Clark and McDonald (1998, 2000), the BEER approach is a modelling strategy designed to seek a long run relationship between observed real exchanges and a set of fundamental determinants derived from a theoretical real exchange rate model. Its has the attractive feature that the real exchange rate is required to be in equilibrium only in terms its value given by the appropriate set of explanatory variables over a specific sample period. This allows representation of the equilibrium real exchange rate in terms of the dynamic structure that generates the data on the real exchange rate and its fundamental determinants (Hinkle & Montiel, 1999), even though the variables themselves are derived from a long run structural model.

Application of the BEER approach requires, as a first step, specification of a behavioural relationship of the real exchange rate and a set of economic fundamentals drawn from a reduced-form theoretical model. This relationship is then estimated to establish the long run impact of fundamental determinants on the real exchange rate. However, since current values of fundamentals may include the influence of transitory factors, the approach also requires judging whether the economic fundamentals determinants themselves are at their long run or sustainable values (Clark & McDonald, 1998). On this, a common practice in the literature is to calibrate values of explanatory variables using a detrending filter such as Hodrick and Prescott's (1997) H-P filter or Beveridge and Nelson (1981) decomposition, both of which decompose a time series variable into its long run trend and short run cyclical value.

The variables' long run trend values obtained from such decomposition are then used to approximate their long run equilibrium values and substituted into the estimated

real exchange relationship to establish the long run equilibrium real exchange rate. Finally, an assessment of misalignment is made by comparing the value for the real exchange generated by this relationship containing de-trended values for the economic fundamentals with the actual value for the real exchange rate. However, because of differences in methodological approaches to identifying fundamental determinants, and those of estimating these relationships, the BEER approach tends to yield different values for the equilibrium real exchange rates and the extent of their misalignments.

All the same, there is somewhat extensive application of the BEER approach to analysis of currencies of developing and middle-income economies. An influential study is Edwards (1989) who applied the methodology to 12 developing and middle income countries from 1962 through to 1984, and found significant misalignments in their currencies. So too did Elbadawi's (1994) study of currencies for Chile, Ghana, and India, and Baffes et al (1999) for Cote d'Ivoire. More recently, Manthisen (2003) used a theoretical model drawn on Edwards (1989) to investigate real exchange rate misalignment in Malawi and found several episodes during which the Malawan Kwacha had experienced several misalignments. However, Cady (2003) found that the Malagasy franc did not seem to have experienced any major misalignments for the most of the 1990s. There is therefore confirmation in the literature that real exchange rates are predictable based on their underlying determinates, despite variations in methodologies used to estimate them.

3 Modelling the rand's equilibrium real exchange rate and assessing the extent of misalignment

We apply the Behavioural Equilibrium Exchange Rate (BEER) methodology, and base our examination of the relationship between the real exchange rate of the rand and its fundamental determinants relying on reduced-form relationships implied by the theoretical model developed in Montiel (1999).

In Montiel's model⁶, the real exchange rate is defined as the relative price of non-traded goods in terms of traded goods, and the long run equilibrium exchange rate is that rate that is consistent with achievement of internal and external equilibrium, when underlying determinants are at their sustainable values. The model develops on the basis of a small open economy with a fixed exchange rate system, financially open to international financial markets, and flexible domestic wages and prices. The production side of the economy consists of producers who produce traded and non-traded goods, and are price takers in the world market. Output in each sector is produced with a fixed, sector-specific, homogenous, and freely mobile labour input, which is also subject to diminishing marginal returns. In both sectors, producers make their allocation decisions on the basis of profit maximization object by setting the marginal product of labour to the wage rate.

The demand side of the economy is modelled in terms of the behaviour of households and the public sector. The behaviour of the representative household reflects its actions to maximize current and future discounted consumption of both the traded and the non-traded good, subject to a wealth constraint, which also determines the path of consumption expenditure. At each period, the actions of the representative household are such that it decides to allocate its net worth between net foreign bonds (financial assets) and domestic money. Bonds can be held either in domestic currency, which pays a nominal interest rate r , or foreign currency, which pays a nominal interest rate, r^* , and the two interest rates are related through an arbitrage relationship described by the uncovered interest rate parity condition. The holding of domestic money, on the other hand, is motivated by the desire to reduce transaction costs related to consumption. This allocation decision defines the representative household's wealth constraint.

The public sector, on the other hand, is a consolidated public sector, made up of the government and the central bank. The central bank's functions are to manage the exchange rate, which it achieves by exchanging domestic currency for foreign currency

⁶ For a similar approach, see also Feyzioglu (1997)

upon demand, and providing credit to government. In addition to receiving credit from the central bank, the government also receives lump-sum taxes from the private sector, which it uses to consume traded and non-traded goods.

With regard to the external position, the country can borrow from and lend to the rest of the world, since the economy is financially open to the rest of the world. However, its financial liabilities are deemed imperfect substitutes for those of the rest of the world. Given this, the rate at which its residents can borrow from or lend to the rest of the world reflects a risk premium, which reflects the country's ability to borrow or its international indebtedness. This is defined by the uncovered interest rate parity arbitrage condition, adjusted for a risk premium.

Given the actions of households, the government, and the country's relationship with the rest of the world, the model, when solved, implies an external and external equilibrium condition for the economy. External equilibrium is attained when the level of consumption and the real exchange yield a sustainable current account balance. This equilibrium condition is represented by the following relationship:

$$\pi^* a^* = y_T(e) + r^* a^* - (\tau^* + \theta)c - g_T \quad (1)$$

Where π^* is the world inflation rate, a^* is the net foreign assets of the country, $y_T(e)$ is traded goods output, inversely related with the real exchange rate, e is the real exchange rate [measured as the relative price of non-traded goods in terms of traded goods], r^* is the foreign nominal interest rate, $r^* a^*$ is interest receipts on net foreign assets, τ^* is the transaction costs associated with consumption, θ is the share of traded goods in total consumption, and g_T is government consumption of traded goods.

In the above expression, the right hand side denotes the current account balance, and equals real national saving (i.e. it shows the surplus over household and government consumption of traded goods). The Left hand side, on the other hand, represents the sustainable value for the country's capital account, which is the value of net foreign

assets adjusted for inflation. These two components together underscore the idea that, in the long run, the real current account must equal the real value of a country's claims on the rest of the world. Because traded goods' output is inversely dependant on the real exchange rate, a fall of its consumption appreciates the real exchange rate.

With regard to internal equilibrium, this holds when the market for labour and the non-traded good clears. This is defined by the following relationship:

$$y_N(e) = c_N + g_N = (1 - \theta) \frac{c}{e} + g_N \quad (2)$$

Where y_N denotes total production of non-traded goods, which is positively related to the real exchange rate, c is total private consumption of the non-traded good, measured in terms of the traded good, g_N is government consumption of the non-traded good. Given the positive relationship between non-traded goods' production and the real exchange rate, increased household and government consumption of the non-traded good will increase its production, and hence appreciate the real exchange rate.

3.1 Factors that determine real exchange rates

Since the equilibrium exchange rate is given as that rate which is consistent with simultaneous achievement of external and internal equilibrium, factors determining this macroeconomic balance condition constitute the real exchange rate's fundamental determinants. In the framework of Montiel's model⁷, these are identified as domestic supply side factors, the stance of fiscal policy, changes in the international financial environment, and the stance of trade and commercial policy.

Domestic supply-side factors

A candidate variable for changes in domestic supply related factors is the relative productivity growth rate between a country and its trading partners, first suggested by Balassa (1964) and Samuelson (1964) and is often referred to as the Balassa-Samuelson

⁷ For a detailed discussion, see Montiel (1999b)

effect. Balassa and Samuelson's argument is that if a country were to experience a productivity shock that increases production in its tradable goods sector relative to its non-tradable goods sector, this would have the effect of appreciating the equilibrium real exchange rate. This would follow because increased output of tradable goods would permit an increase in demand for labour in favour of this sector, and hence the real wage. Resulting from this, a shift in labour from the non-tradable goods sector would be expected, which, at the given real exchange rate, would mean an expansion of the tradable sector while the non-tradable sector would contract. This would have the effect of creating excess demand in the non-tradable goods sector; thereby give rise to a higher relative price non-tradable. By increasing production of tradables relative to non-tradables, the productivity shock also gives rise to a trade surplus, which means that the real exchange rate would have to appreciate to maintain external equilibrium. Accordingly, countries that experience higher rates of productivity growth in their tradable goods sectors relative to their trading partners are expected to experience appreciations of their real exchange rates (Aghevli et al, 1991).

Stance of fiscal policy

Fiscal policy has an ambiguous effect on the equilibrium real exchange rate: the direction of its quantitative influence depends on the sectoral composition of the change in government expenditure. If government increased its expenditure on tradable goods, this would have the effect of increasing demand for tradable goods through an increase in import consumption, thereby creating a trade deficit. To maintain external equilibrium, a depreciation of the real exchange rate would be required. By contrast, increased government expenditure on non-tradable goods will tend to create excess demand in the non-tradable goods market. To maintain goods market equilibrium, an increase in the relative price of non-traded goods would be required, thereby appreciating the real exchange rate. Thus, changes in the stance of fiscal policy can either depreciate or appreciate the real exchange rate.

Factors related to changes in the country's international economic environment

Aspects of changes in a country's international economic environment considered in the literature include changes in the terms of trade. Here an improvement in a country's terms of trade, which refers to an increase in the price of its exportable goods relative to importable goods, is expected to appreciate the real exchange rate. This follows because increases in the price of exports permit an expansion of the export sector output, and thus gives rise to excess supply of exportable goods and a trade surplus. This increase in export sector output would allow an increase in the real wage in the traded goods sector relative to that of the non-traded goods sector. As a result of this, a redistribution of labor from the non-traded to the traded goods sector would be expected. At the same time, output of non-traded goods would be expected to contract, thereby creating excess demand in the non-traded goods market, and thus a higher relative price. Both the improvement of the trade balance and the rise in the price on non-tradable goods require an appreciation of the real exchange rate if equilibrium is to be maintained. However, MacDonald and Ricci (2003) point out that "in practice few studies find the terms of trade variable to be significant" largely on account of the arbitrariness involved in calculating this variable (p. 4). Thus an alternative approach used has been to proxy the terms of trade variable with real commodity price movements of major commodity exports, which is not only an accurate measure particularly for major commodity exporters, but has also received empirical support (MacDonald & Ricci, 2003).

Another factor connected to the change in a country's international financial environment is the flow of international capital and transfers. Increases in the flow of capital imply a higher net foreign asset position of the country, which increases the country's level of real income. This then permits a larger expenditure on domestic (non-tradable) goods (MacDonald & Ricci, 2003), creating excess demand and a rise in the price of non-tradable goods. As a result, an appreciation of the real exchange rate would be expected.

Changes in a country's real interest rate differential relative to its trading partner countries will also tend to appreciate the equilibrium real exchange rate. For an economy that is highly open to international capital markets, a higher domestic real interest relative

to that of its trading partners, representing say aggregate demand conditions, productivity levels, or persistent tightening of monetary policy (MacDonald & Ricci, 2003), creates opportunities for capital to flow to that country. As a result, an improvement of the current account would be expected, thereby appreciating the real exchange rate.

By contrast, changes in the world inflation rate will tend to cause a depreciation of the equilibrium real exchange rate. The transmission mechanism for this is through the effects of inflation on transaction costs associated with changes in the real demand for money. The direction of such transactions costs on the equilibrium real exchange rate will tend to depend on whether they are incurred through consumption of traded or non-traded goods, which in both cases, reduces their supply. In the case of traded goods, this would require a real exchange rate appreciation. For non-traded goods, the implication is that the real exchange rate should depreciate. To the extent domestic prices reflect the relative price of non-traded goods, a higher domestic inflation for a country relative to that of its trading partners would imply a depreciation of its real exchange rate.

Stance of trade and commercial policy

Finally, greater openness of the trade regime by way of trade liberalization is expected to cause the equilibrium real exchange rate to depreciate. The effect of trade liberalization works by channelling resources from the tradable sector into the non-tradable sector. For instance, a tariff reduction would have the effect of reducing the relative price of importables and also creating excess supply both exportables and non-traded goods (Aghevli, et al, 1991). Here the emergence of excess supply in the non-tradable goods sector permits a depreciation of the equilibrium real exchange rate.

3.2 Empirical Application

3.2.1 Specification of the empirical model

On the basis of theoretical motivations discussed above, we expect the following factors to influence real exchange rate movements of the rand,

- the real interest rate differential vis-à-vis South Africa's main trading partners,
- the inflation differential vis-à-vis South Africa's main trading partners,
- variations in the terms of trade for South Africa,
- the level and composition of government expenditure [stance of fiscal policy],
- relative technological or productivity progress [proxy for Balassa-Samuelson effect] vis-à-vis South Africa's main trading partners,
- international capital flows,
- openness of the trade regime [proxy for the stance of commercial and trade policy],
- the stock of foreign currency reserves, and
- the stock of foreign debt.

Accordingly, our empirical model has the following specification:

$$q_t = \alpha + \beta'F_t + \varepsilon_t \quad (3)$$

Where q_t denotes the rand's real exchange rate, and F_t is a vector of fundamental variables mentioned above, β is a vector of coefficients, and ε_t is a random error term. Specifically, $F_t = [(r_t - r_t^*), (\pi_t - \pi_t^*), tot_t, gxp_t, prod_t, ka_t, open_t, fx_t, fxb_t]'$ where $r_t - r_t^*$ is the real interest rate differential for South Africa relative to its main trading partners, $\pi_t - \pi_t^*$ is the inflation differential, tot_t is the terms of trade, gxp_t is government

consumption (expenditure), $prod_t$ is relative productivity growth (proxy for Balassa-Samuelson effect), ka_t is international capital flows, $open_t$ a measure for openness of the trade regime, fx_t is foreign currency reserves, fxb_t is foreign debt, and the asterisk (*) denotes foreign variables.

The real interest rate differential, terms of trade, productivity growth, capital flows, and foreign reserves all enter the model with a positive sign, since these variables are expected to appreciate the real exchange rate. Conversely, the inflation rate differential, trade openness, and foreign debt variables depreciate the real exchange rate, and are thus specified with a negative sign, whereas as the expected impact of government expenditure is ambiguous.

3.2.2 Testing methodology

In the specification discussed above, the object of interest is one of testing whether a long run relationship exists between the rand's real exchange rate with this set of fundamental determinants by estimating β , the vector of parameters. Our choice of the methodology to accomplish this was dictated by properties of our data. Together with other macroeconomic variables, exchange rates appear to possess non stationary stochastic trends that allow variables to grow overtime with no tendency to revert to their mean values. The presence in the data of such non stationary stochastic trends is known to invalidate standard statistical inferences. Thus, we employed cointegration analysis, which addresses this non stationary problem in the data. Cointegration tests have the benefit of allowing one to test for and estimate equilibrium relationships among variables and the adjustment process to such equilibrium, even though the processes that generate the data are themselves non stationary stochastic trends.

In the literature on cointegration analysis, various approaches have been suggested, bordering on both single equation and multiple equations approaches (see Pesaran & Pesaran 1997). For our purposes, we applied Johansen's (1991, 1995) multivariate cointegration tests, which examines the problem of testing for cointegrating relationships in the context of a system of jointly determined non-stationary variables that are generated

as a vector autoregressive (VAR) process, and “models the relationships among the variables using a vector equilibrium correction specification” (Cady, 2003, p.4). This starts with examining a VAR model of the following form:

$$Z_t = a_0 + a_1 t + \sum_{i=1}^p \Psi_i Z_{t-i} + B_0 w_t + U_t \quad (4)$$

Where Z_t is an $n \times 1$ vector of jointly determined non-stationary $I(1)$ variables (here n is the number of variables in Z), w_t is a vector of exogenous stationary $I(0)$ variables, t is a deterministic trend variable, a_0 is a vector of intercept coefficients, Ψ_i is an $n \times n$ matrix of coefficients, B_0 is $n \times 1$ vector of coefficients on exogenous stationary variables, and U_t is an $n \times 1$ vector of white noise error terms.

When cointegrating relationships are present among the jointly determined variables, the above vector autoregressive process gives rise to a dynamic vector equilibrium-correction [error-correction] model (VECM), which is essentially “a restricted vector autoregressive process that has co integration restrictions built into the specification” (*Eviews3.0 Users Guide*, p.504). This specification follows from Engle and Granger’s (1987) representation theorem which says that if a group of non-stationary data processes are co integrated, they can be regarded as having been generated by an equilibrium correction process that restricts the long run behavior of jointly determined variables to their long run values while allowing for a series of partial adjustments over the short run (Maddala & Kim, 1998). Hence we may rewrite the VAR process into its VECM form as follows;

$$\Delta Z_t = a_0 + a_1 t + \Pi Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + B_0 w_t + U_t \quad (5)$$

Where $\Pi = -(\mathbf{I} - \sum_{j=1}^p \Psi_j)$ and $\Gamma_i = -(\mathbf{I} - \sum_{i=1}^{p-1} \Psi_i)$.

Here Π denotes a matrix of long run coefficients that defines long run relationships among the variables, while Γ_i is a coefficient matrix capturing short run dynamic adjustments among the variables (Pesaran & Pesaran, 1997).

When specified in this VECM form, a vector autoregressive process has the advantage of providing information on both the long run relationships among the variables and their short run adjustment to such long run equilibrium relationships. To begin with, since the matrix Π contains the long run coefficients that underlie long run relationships among the variables, the relation ΠZ_t represents the long run equilibrium relationships among the variables. The relations contained in the lagged term ΠZ_{t-1} serve as equilibrium correction devices that ensure that the short run adjustments of variables are tied to their long run values overtime. Secondly, the terms ΔZ_{t-i} represent the short run dynamics or deviations of the variables from their long run equilibrium, whose impact is represented by Γ_i . Since cointegration is assumed in this formulation, ΠZ_{t-1} is stationary, as is ΔZ_{t-i} considering that Z_{t-i} is itself a non-stationary $I(1)$ process. As a result, the vector error-correction model is a stationary process, which allows application of standard inference statistics even though the elements of the system are themselves non-stationary. The vector error-correction model is thus appropriate to model non-stationary data processes that are cointegrated.

Because the matrix Π contains long run coefficients, and thus provides information on about long run relationships among the variables, the presence of co integration among the variables is indicated by the rank of this matrix, which requires finding r , the number of linearly independent columns that are present in the matrix. Three cases are distinguishable in this respect:

- Case (I). If the matrix Π is of full rank, corresponding to $r = n$ (where n equals the number of variables in the system), then there exist $r = n$ linearly independent columns in the matrix Π . In this case, the variables in Z_t are stationary, and no co-integration exists among the variables. A VAR model with variables specified in their levels is thus the appropriate model.
- Case (II). On the other hand, if the rank of the matrix Π is zero, when the elements in Z_t are non-stationary, then no cointegration exists among the variables. A VAR

model with variables specified in their first differences in the appropriate model in this case.

Case (III). Finally, if the matrix Π of reduced rank when the elements in Z_t are non-stationary, then there exist at most $r \leq n - 1$ linearly independent columns in the matrix Π , which indicates the presence of r co-integrating relations in Z_t . In this case, the VECM specification is the appropriate framework for modelling the relationships among the variables.

Accordingly, the hypothesis of the existence of co-integrating relationships among the variables can be formulated in terms of a hypothesis of the reduced rank of matrix Π . This can be stated as follows:

$$H_0(r): \text{rank}(\Pi) = r \leq n - 1.$$

Under this hypothesis of co-integration (i.e. case iii above), the pie matrix is equivalent to $\Pi = \alpha\beta'$, which flows from Engle and Granger's (1987) representation theorem. Here α is a full column rank $n \times r$ matrix representing the speed of adjustment of variables in the model, whereas the matrix β is also a full column rank $n \times r$ matrix of long run coefficients, with the property that $\beta'Z_t$ is stationary. In the light of this decomposition of the pie matrix, the vector error-correction model can be written as follows:

$$\Delta Z_t = a_0 + a_1 t + \alpha\beta'Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + B_0 w_t + U_t \quad (6)$$

In this vector error correction specification of the VAR model, the stationary cointegrated relationships among the variables are now defined by $\xi_t = \beta'Z_{t-1}$, and this characterizes the long run relationships among the variables. As a result, the hypothesis on the rank of the matrix Π is now equivalent to formulating a hypothesis about the rank of the matrix β' , which has the implication that each column of β' is the cointegrating vector (*Eviews5.0 Users Guide*, p. 723). We may restate this as follows:

$$H_0(r) : \text{rank}(\Pi) = \text{rank}(\beta') = r \leq n - 1$$

Testing for cointegration therefore requires an estimate of the pie matrix $\Pi = \alpha\beta'$.

In the Johansen's approach, this is achieved by estimating the pie matrix $\Pi = \alpha\beta'$ from the unrestricted VAR model, and then testing whether the restrictions imposed by the reduced rank of matrix Π can be rejected by the data (*Eviews5.0 Users Guide*, p. 724). This is tested using two types of tests advocated by Johansen. The first is the trace statistic, which allows one to perform a log likelihood ratio (LR) test for the null hypothesis that there exist r co integrating vectors against the alternative of n co integrating vectors (where n is the number of endogenous variables in the VAR). This statistic is computed as follows:

$$LR_{\text{trace}} = -2\log(Q) = -T \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i) \quad (r = 0, 1, \dots, n-2, n-1)$$

The second is the maximum eigenvalue ($\lambda - \max$) statistic. This is a log likelihood test that tests the null hypothesis that there is r co integrating vectors against the alternative that there is $r + 1$ co integrating vectors. This statistic is computed as follows:

$$LR_{\text{max}} = -T \log(1 - \hat{\lambda}_{r+1}) \quad (r = 0, 1, \dots, n-2, n-1)$$

Asymptotic critical values for conducting these two tests have been provided by Johansen (1988), and also Osterwald-Lenum (1992).

However, more often, the data series under investigation will not only exhibit stochastic trends, but may also exhibit non-zero means and or deterministic trends. In this event, the co integrating relations among these data series will also exhibit non-zero means and or deterministic trends, and this would have to be taken into account during the course of investigation. But these log likelihood ratio statistics for the testing for the presence of co integration discussed above do not poses the usual chi-square statistics, and have been found dependant upon the trend assumptions underlying the data under

investigation (*Eviews5.0 User's Guide*, p. 724). Because of this, the underlying data trends would have to be ascertained prior to implementing the tests. On this, five trend assumptions on whether the data series contain intercepts and or time trends, and whether the intercepts and or time trends are restricted (i.e. form part of the co integrating relations) are distinguishable (Pesaran & Pesaran, 1997)⁸:

- Case (I). The level series data have no trends and the co integrating relations have no intercepts (i.e. $a_1 = a_2 = 0$).
- Case (II). The level of the data have no deterministic trends and the co integrating relations have intercepts (i.e. restricted intercepts and no trends in co integrating relations, $a_1 = 0$ and $a_0 = \Pi\rho_0$ where ρ_0 denotes an intercept coefficient).
- Case (III). The level data have linear trends but the co integrating relations have only intercepts (i.e. unrestricted intercept and no trends, $a_1 = 0$ and $a_0 \neq 0$).
- Case (IV). Both the level data and the co integrating relations have linear trends (i.e. unrestricted intercept and restricted trend, $a_0 \neq 0$ and $a_1 = \Pi\gamma_0$ where γ_0 denotes a trend coefficient).
- Case (V). The level data have quadratic trends and the co integrating relations have linear trends (i.e. unrestricted intercept and trend, $a_0 \neq 0$ and $a_1 \neq 0$).

In practical application, determination of the number of co integrating relations using the Johansen's method is a sequential process conditional on the trend case assumption discussed above, testing first the hypothesis that $r = 0$, and then proceeding to $r = n - 1$ until the test fails to reject the hypothesis. After determining the number co integrating relationships among the variables, the next step is to estimate of the vector equilibrium-correction model in order to examine the long run predictability and short run forecasting ability of the model.

⁸ For further discussion of the five trend case assumption, see also *Eviews5.0 Users Guide* (pp.724-727) and Pesaran and Pesaran (1997, pp. 132-136)

Tests for the order of integration of variables

However, testing for cointegration is valid only when the variables are generated by a non-stationary process. Ascertaining the order of integration of the data under investigation is therefore a key preliminary step to its application. One widely used methodology for testing the order of integration of variables, which this study employs, is Dickey and Fuller's (1979, 1981) DF and ADF tests. This tests whether $\rho = 1$, which is a test for existence of a unit root, assuming that the time series data under investigation is generated by a first order autoregressive process of the following form:

$$s_t = \alpha_0 + \alpha_1 t + \rho s_{t-1} + \varepsilon_t \quad (7)$$

Where α_0 is a constant, t is a deterministic trend, and ε_t , is a white noise stochastic process. Alternatively, the above autoregressive process can be written as follows.

$$\Delta s_t = \alpha_0 + \alpha_1 t + \gamma s_{t-1} + \varepsilon_t \quad (8)$$

Where $\gamma = \rho - 1$.

The ADF test is performed on this re-parameterized form of the autoregressive process. In particular, the hypothesis for existence of a unit root is formulated as $H_0 : \gamma = 0$, under which case the process $\{s_t\}$ is said to be a non-stationary $I \sim (1)$, against the alternative $H_a : \gamma < 0$, which has the implication that the process is stationary. However, in its practical applications, the ADF test requires estimating a more general autoregressive process that includes lagged differences of the variable under investigation, which are included in order to control for autocorrelation in the stochastic error term. In terms of this consideration, the test involves estimating the following regression model;

$$\Delta s_t = \alpha_0 + \alpha_1 t + \gamma s_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta s_{t+i} + \varepsilon_t \quad (9)$$

Under the null hypothesis of a unit root process, the distribution for the t-statistic is not asymptotically normal, and as such, one cannot use the usual t-test to assess the statistical significance of γ . Nevertheless, Dickey and Fuller have provided appropriate critical values for testing the unit root hypothesis. But, these have since been revised and extended by MacKinnon (1991), who has provided estimates that are appropriate for any sample size (*Eviews 3.0 Users Guide*, p. 329).

3.2.3 Data definitions and sources

We employed a data set on variables consisting of quarterly observations from the first quarter of 1970 to the fourth quarter of 2003, which we obtained from *I-Net Station Bridge* online statistical database, International Monetary Fund's *International Financial Statistics (IFS)* online database, and South African Reserve Bank's (*SARB*) online database. A more detailed description of the variables and their data sources is given below, while their graphical presentation during the period under review is given by figure 3-1.

Real exchange rate

We used the CPI-based real effective exchange rate index (REER) for the rand, calculated by the South African Reserve bank as the average value of nominal bilateral exchange rates of the rand with respect to 13 countries, weighted by the volume of trade between South Africa and these countries and adjusted for movements in their respective consumer price index differential⁹. Its definition here in terms of foreign currency per unit of the rand, so that an increase in the real effective exchange rate denotes an appreciation. The weighting structure used in the calculation of the index is described in South African Reserve Bank (1999), and this is based on the methodology described in Zanello and Desruelle (1997). Of the thirteen currencies in the basket, the

⁹ For details, see South African Reserve Bank (2003, p. S109)

four major currencies are the euro, with a weight of 36.30%, the British pound with 15.37%, the US dollar with 15.47%, and the Japanese yen with 10.43%. Together, these four major currencies account for 77.6% of total weighting of the basket. This variable is expressed in logarithms as *LREER* and the data was obtained from *I-Net Station Bridge*.

Real Interest rate differential

This is the real yield rate on the 10 year South African government bond relative to the real yield rate on the 10-year government bond for trading partner countries. The real interest rate was calculated as the nominal interest rate minus four-quarter CPI-inflation rate for each country. For the trading partner countries, this was calculated as a weighted average of four major trading partners based on trade weights for the real effective exchange¹⁰. The weights used for the four major trading partner countries [shown in brackets] are the following: Germany (proxy for the European Union, 42%), United States (21%), United Kingdom (21%) and Japan (16%). This variable is denoted *RGBRDD*. The data source for nominal interest rate on the 10 year government bond and consumer price index for each country is the *IFS*.

Fiscal position

We employed two alternative measures for the fiscal position variable. One which we have denoted *FBA* is the ratio of the fiscal balance (budget deficit) to Gross national Product (GDP) expressed as percentage. The data source for this variable is *South African Reserve bank (SARB)*. The other which we have denoted *GVERT* is the ratio of government expenditure to GDP expressed as a percentage. The source of data for this measure is *I-Net Station Bridge*.

Terms of trade

We used three alternative measures for the terms trade variable, all expressed in natural logarithms. The measure denoted *LGOLPRN* is an index of the real gold price normalized to 1 in 2000, defined as the London market US dollar price of gold deflated by the US consumer price index¹¹. The data source for this series is *IFS*. The other

¹⁰ See also MacDonald and Ricci (2003)

¹¹ See also the definition in MacDonald and Ricci (2003)

measure which we have denoted *LTOTGN* is an index of the ratio of exports prices to import prices including the price of gold, normalized to 1 in 2000. Finally *LTOTN* is an index of the ratio of export to import prices excluding the price of gold, also normalized to 1 in 2000. The data source for both the latter series is *SARB*.

Productivity growth differential

No source data is available for this variable. However, in the empirical literature, this variable is often proxied by other closely related variables on which data is available such as real GDP per capita or variables connected to measures of education and demographic factors (Egert, 2002, p.5). In line with this approach in the empirical literature, we measured this variable by relative real GDP per capita, which effectively measures labour productivity as real GDP divided by total population, and is meant to capture the effects of labor productivity increases of the home country relative to the foreign country (Maeso-Fernandez, 2001, p. 13). The foreign variable used in the calculation was measured as a weighted average of real GDP per capita for the four trading partner countries, based on weights for the real effective exchange rate, and normalized to 1 in 2000 for each country. This variable is expressed in natural logarithms and is denoted *LG DPRKDN*. The data source is *SARB* for South Africa, and *IFS* for the four trading partner countries.

Trade and commercial Policy

This was measured by an openness variable, calculated as the ratio of the sum of exports and imports (i.e. total trade) to GDP, and expressed as a percentage. This variable is denoted *OPEN*, and the data source for the export, the import, and the GDP variable is *SARB*.

Foreign reserves

We employed two measures for the stock of foreign reserves. The first, denoted as *NFAMS*, is the stock of net foreign assets of the banking system, defined as total foreign assets of the banking system minus total foreign liabilities, expressed as a percentage of GDP. The data source for this variable is *IFS*. The other is *FXRR*, which is the stock of total gross reserves, expressed as a percentage as a percentage of GDP. The data on this variable was obtained from *INet Station Bridge*.

Inflation differential

This is the four-quarter CPI inflation rate for South Africa minus the four-quarter CPI for the four trading partner countries, with the foreign variable computed in similar manner as above. This variable is *INFLRD*, and the source for the data is *IFS*.

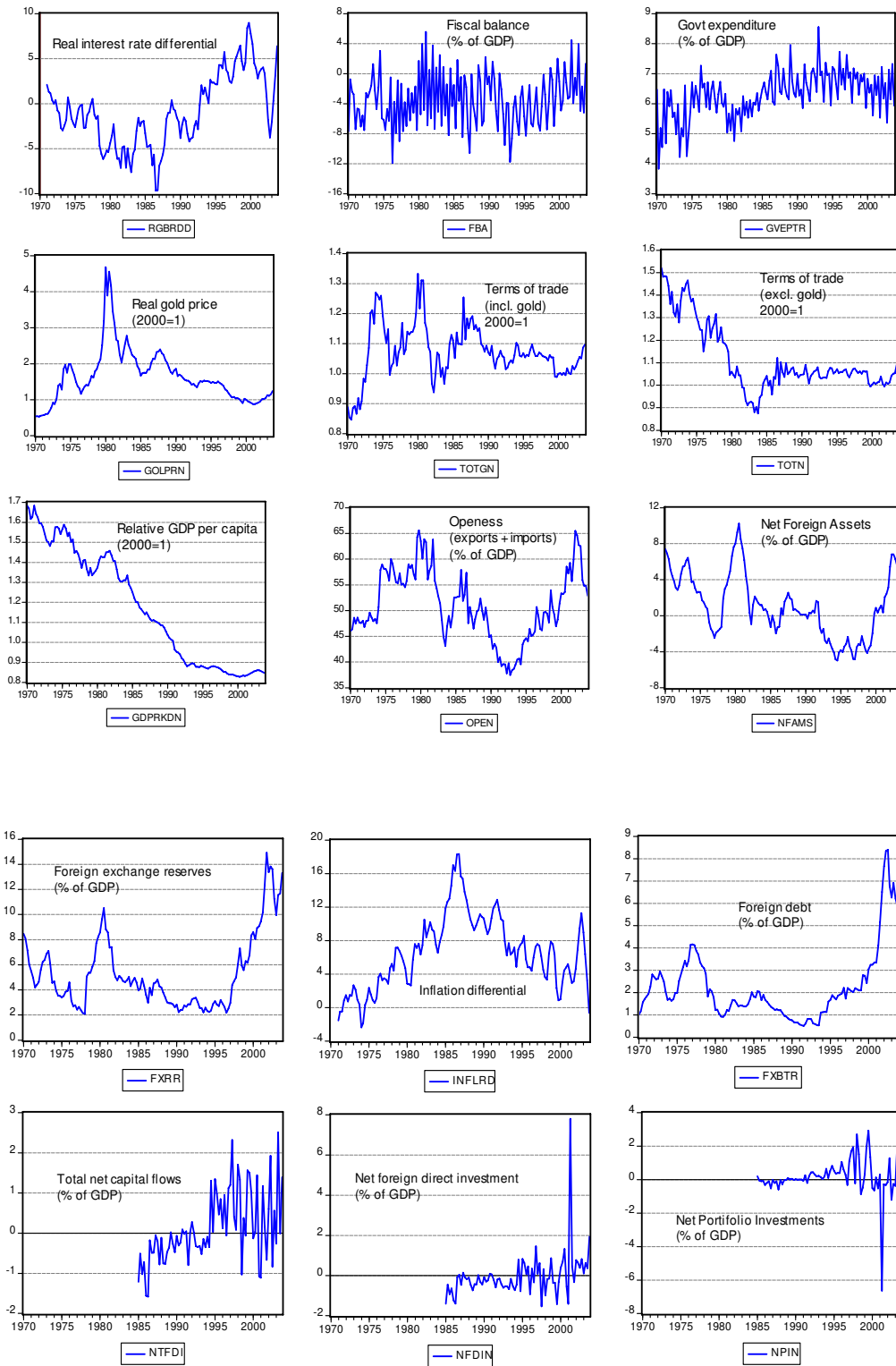
Foreign debt

This is the ratio of total foreign debt for South Africa to GDP, in percentage. This variable is labelled *FXTBR*, and the data source is *INet Station Bridge*.

Capital flows

We employed two measures for the capital flows variable. The series labelled *NTFDI* is the ratio of the sum of net foreign direct investment capital flows, net other investment capital flows, and net portfolio investment capital flows to GDP, in percentage. On the other hand, *NFDIN* is the ratio of net foreign direct investment capital flows to GDP, in percentage. The data source for both series is *SARB's*, capital movements' database. A quarterly database for both series is available only from 1985.

Figure 3-1: South Africa: fundamental determinants of the real exchange rate



3.2.4 Empirical results

3.2.4.1 *Tests for the order of integration of variables: the Dickey-Fuller test*

As a preliminary step, we began our empirical analysis with application of Dickey-Fuller's ADF tests on the data so as to ascertain the order of integration of the data employed by the study. In carrying out Dickey-Fuller ADF tests for the presence of unit roots, however, the appropriate test regression (i.e. whether to include a constant or trend) needs to be selected. In our case, we followed the approach of Hamilton (1994, pp. 501-02) who has suggested including a constant and trend whenever the data appears to contain either a stochastic or deterministic trend, while a constant should only be included when no trend is apparent in the data. A graphical representation of the data (figure 3-1) showed no trend in all but the labour productivity variable. Rather, the data appears to fluctuate around a non-zero mean. Thus, employed the linear trend test regression model to test the unit root hypothesis on the labour productivity variable, and drift model on the rest of the variables.

The other issue that needed to be considered when applying the ADF testing procedure is selection of the lag length for the test regression (i.e. the number of lagged values for the first difference of the dependent variable). We determined this based on test statistics provided by the Akaike Information (AIC) and Schwarz Bayesian (SBC) information criterion for selecting the lag length, starting from a maximum lag length of twelve.

The unit root test results for the Dickey-Fuller ADF tests are tabulated in table 3 below. The evidence presented in this table show that the unit root hypothesis can not be rejected in the level of the data series in all but the variable for the terms trade including the gold price and the capital flows variables defining foreign direct investment as a percent of GDP, which are both rejected at the 1% level of significance. In the first difference of each individual series, however, the null hypothesis of a unit root is rejected in all the series. Thus, the data prove to be non-stationary with a unit root, save

for the terms trade including gold price and capital flows defining the share of foreign direct investment in GDP.

Table 3-1: Results of Dickey-Fuller's unit root tests for stationarity properties of the data

Description	Null order Variable	I(1)			I(2)		
		ADF _c	ADF _{ct}	P	ADF	ADF _c	P
		Real exchange rate	LREER	-2.84		3	-5.72***
Interest rate differential	RGBRDD	-1.37		4	-7.56***		3
Fiscal position	FBA	-2.84		4	-8.44***		3
Terms of trade	GVEPTR	-2.58		4	-7.77***		3
	LGOLPRN	-3.05		3	-4.05***		2
	LTOTGN	-4.20***		4			
Productivity differential	LTOTN	-2.48		1	-15.98***		0
	LGDPKDN		-1.97	4		-10.86***	0
	Commercial policy	OPEN	-2.47		1	-13.40***	
Foreign reserves	NFAMS	-1.92		1	-8.08***		0
	FXRR	-0.88		1	-9.61***		0
Inflation differential	INFLRD	-1.83		12	-4.89***		11
Foreign debt	FXBTR	-1.29		1	-8.07***		0
Capital flows	NTFDI	-1.89		3	-9.45***		2
	NFDIN	-8.45***		0			

Explanatory notes:

- The ADF_{ct}, ADF_c and ADF denote the Augmented Dickey-Fuller test statistic, including a constant and trend, a constant only, and no constant and no trend in respective order.
- The asterisks (***) denote statistical significance at the 1% level of significance.
- P is the order of augmentation (lag length) of the ADF test regression, chosen using the Akaike Information (AIC) and Schwartz Information criterion (SIC) for selecting the lag length from a maximum of 12 lags.
- The critical values are the non-standard Dickey-Fuller regression as reported in Mackinnon (1991, 1996), and are provided here as part of *Eviews 5.0* output.
- At the 1% level of significance, the critical value is -4.03 with constant and trend, -3.48 with constant, and -2.58 when neither constant nor trend is included in the test regression.

Confirmation of non-stationarity of most of the data series employed enabled us to use a vector equilibrium correction model investigate existence of a long run relationship of the real exchange rate and the set of fundamental determinants. We investigated different specifications of our empirical models within the context of the VECM, which we distinguished in two respects. First, we used different empirical definitions for the fiscal variable, the terms of trade variable, the foreign reserves variable, and the capital flow variable. Secondly, we estimated the models over two different sample periods.

In the specifications labelled 1B and 2A, the vector equilibrium model was estimated using a sample of data spanning from the first quarter of 1972 to the last quarter of 2003. The specific combinations of variables examined are as follows:

- *Model 1B* consists of the real effective exchange rate of the rand (LREER), the real interest rate differential on the 10 year government bond between South Africa and the four major trading partners (RGBRDD), the fiscal deficit as a share of gross domestic product (FBA), the real US dollar gold price (LGOLPRN), the relative real gross domestic product per capita between South Africa and the four major trading partners (LGDPRKDN), total trade as a ratio of gross domestic product (OPEN), the total stock of gross foreign reserves as a ratio of gross domestic product (FXRR), the inflation rate differential between South Africa and the four major trading partners (INFLRD), and the stock of foreign debt measured as a ratio of gross domestic product (FXBTR).
- *Model 2A* distinguishes 1B by examining the influence of the fiscal variable in terms of the share of total government expenditure in gross domestic product (GVEPTR)

Regarding specifications 4A, 4C, 5B and 5C, these were estimated using data from 1985q1 through to 2003q4, partly to assess the robustness of the model, and also to examine the influence of the capital flows variable, whose data at the quarterly frequency is available only from 1985. The particular variables included in each model are as follows.

- *Model 4A* comprises the real exchange rate (LREER), real interest rate differential (RGBRDD), fiscal balance (FBA), productivity differential (LGDPRKDN), real gold price (LGOLPRN) openness (OPEN), net foreign assets (NFAMS), foreign debt (FXBTR) and Capital flows (NTFDI).

- *Model 4C* employed the same variables as in 4A, but the term of trade variable was assessed in term of LTOIN, the ratio of export to import prices excluding gold price.
- *Model 5B* has the same order of variables as 4C, but the fiscal variable is now examined in terms of GVEPTR, the ratio of total government expenditure to GDP, and the foreign reserves variable employed is FXRR, the total stock of gross reserves as a percentage of GDP.
- Finally, in *model 5C*, the influence of the capital flows variable is assessed in terms of the ratio of net foreign direct investment to gross domestic product (NFDIN).

In estimating these VECM specifications of the empirical model, both the nature of the intercept and trend, and the lag structure in the underlying VAR model had to be ascertained. In the case of trend specification, we chose option three of the five trend case assumptions discussed previously, which restricts the intercept seeing that our data is not trended but appear to fluctuate around a non-zero mean. With regard to the order of the VAR, we included four lags of each variable in their first differences as our analysis employs quarterly data¹². Also included in the specifications are three seasonal dummies (SR1, SR2, & SR3) which are meant to control for the effects of seasonality in the data. We tested for the appropriateness of this lag structure using the chi-square statistic for the wald test for joint lag exclusion, testing the null hypothesis that the lags are jointly not significantly different from zero, which, if accepted, implies that the lags should be excluded. The results of this lag exclusion test, presented in table 3-2, show that this null hypothesis is not supported by the data, suggesting that the lag structure is appropriate.

We also examined a number of the models' diagnostics so as to assess the statistical adequacy of our model's specifications. Table 3-3 presents chi-square statistics on testing

¹² MacDonald and Ricci (2003, p.11) note that such a structure is common when employing quarterly data.

the null hypotheses of normality and serial correlation in estimated residuals. According to these statistics, the estimated residuals appear free from serial correlation. In terms of normality, the null hypothesis of normality in the distribution of estimated residuals is accepted with regard to skewness and the Jarque-bera test, but tests for excess kurtosis reject the normality hypothesis. However, MacDonald and Ricci (2003) point out that cointegration test results are not affected if normality is rejected because of the presence of excess kurtosis; hence, we proceeded in our analysis in this light.

Table 3-2: Chi-squared statistics for joint VEC lag exclusion Wald test

Model	1B	2A	4A	4C	5A	5C
Dlag1	225.0 (0.00)	238.1 (0.00)	342.5 (0.00)	362.2 (0.00)	250.7 (0.000)	277.3 (0.000)
Dlag2	94.3 (0.15)	100.6 (0.07)	250.1 (0.00)	224.3 (0.00)	136.1 (0.000)	211.4 (0.000)
Dlag3	157.8 (0.00)	141.1 (0.00)	218.0 (0.00)	226.2 (0.00)	104.0 (0.001)	261.0 (0.000)
Dlag4	111.5 (0.01)	114.5 (0.01)	237.7 (0.00)	195.2 (0.00)	96.4 (0.005)	209.3 (0.000)
DF	81	81	81	81	64	64

Notes:

- (1) Ho: lag's coefficient are jointly not significantly different from zero, which, if accepted, implies the lags should be excluded
- (2) P-values in parenthesis
- (3) DF denotes degrees of freedom

Table 3-3: Chi-square statistics for joint tests of VEC model diagnostics

Model	1B	2A	4A	4C	5B	5C
Normality						
<i>Skewness</i> \ (1)	10.7 (0.3) [9]	10.1 (0.3) [9]	0.6 (1.0) [9]	0.4 (1.0) [9]	1.7 (1.0) [8]	0.4 (1.0) [8]
<i>Kurtosis</i> \ (2)	80.9 (0.0) [9]	81.9 (0.0) [9]	159.1 (0.0) [9]	162.0 (0.0) [9]	117.8 (0.0) [8]	127. (0.0) [8]
<i>Jarque-Bera</i> \ (3)	91.6 (0.0) [18]	92.0 (0.0) [18]	160.0 (0.0) [18]	162.2 (0.0) [18]	119.6 (0.0) [16]	128. (0.0) [16]
Serial correlation						
<i>LM</i> \ (4)	83.7 (0.4) [81]	85.7 (0.3) [81]	66.9 (0.17) [81]	79.8 (0.52) [81]	77.6 (0.12) [64]	57.6 (0.7) [64]

Notes:

- (1) Ho: residuals have no skewness
- (2) Ho: residuals have no kurtosis
- (3) Test for normality of residuals. Ho: residuals are normal
- (4) Ho: no serial correlation at Dlag 4
- (5) P-values in parenthesis
- (6) Degrees of freedom in square brackets
- (7) (*) denotes statistical significance at the 1% level

Table 3-4 presents results of testing for cointegrating relationships among the variables based on the VECM model specifications described above. The results reported are the number of co-integrating relationships present among the variables based on the trace statistic and maximum eigen-value statistic for testing the hypothesis

of co-integrating relationships among the variables, both evaluated against their corresponding 5% asymptotic critical values. In terms of these results, both statistics indicate the presence of co-integrating relations among the variables examined, but give conflicting conclusions on the number of co-integrating relationships present, ranging 3 to 9 co-integrating relations under the trace statistic and 1 to 5 co-integrating relations under the maximum eigen-value statistic. The co-integration tests results are thus uninformative about the number of co-integrating relations present in the data. Nonetheless, Pesaran and Pesaran (1997, p.293) have pointed out that “often both the trace and maximum eigen-value statistics result in conflicting conclusions, and the decision concerning the choice of the number of cointegrating relations must be made in the light of other information available or based on economy theory”. In our case, the main interest is in examining the predictability of the real exchange rate in terms of the set of variables under consideration. In the light of this, we proceeded in our analysis as if there is one co-integrating relation present among the variables and focused on the co-integrating relation explaining the real effective exchange rate for the rand, which we obtained by normalizing the coefficient to the exchange rate variable to unity¹³.

Table 3-4: Results of Johansen’s cointegrating test

Model	1B	2A	4A	4B	4C	5B	5C
Number of co-integrating relationships							
<i>Trace Statistic (@ 5% C.V)</i>	3	4	9	5	5	5	5
<i>Maximum eigenvalue statistic (@ 5% C.V).</i>	1	2	5	5	5	3	4

3.2.4.2 The rand’s long run real exchange rate

In Table 3-5, we report results of estimating the co-integrating relation explaining the real exchange rate of each individual specification of our empirical model, which we

¹³ See also Pesaran et al (2000) for a similar approach.

obtained by normalizing on the coefficient of the exchange rate variable. The results reported in this table are the estimated coefficients on co-integrating variables and their corresponding t-statistics, shown in parentheses. In our initial estimations of this co-integrating relation, we found that the coefficient on INFLRD, the inflation differential variable, was wrongly signed in model 1B, while FXBTR, the foreign debt variable had its coefficient wrongly signed in models 1B and 2A. We also obtained a similar result for the terms of trade variables LGOLPRN in model 4A and the foreign debt variable FXRR in model 5C. We imposed coefficient restrictions that these coefficients were zero in their respective equations, which we tested using a chi-square statistic of the wald test for testing the coefficient restriction hypothesis.

The coefficient restrictions, if accepted, imply that the variables should be excluded from the analysis or alternatively the model should be estimated subject to these restrictions. The results of this exercise, showing the estimated chi-square statistic, corresponding probability values, and the number of restrictions imposed, are shown at the bottom of table 3-5, and these indicate that the restrictions are accepted by the data. Hence, we proceeded in our analysis of the co-integrating relation conditional on these coefficient restrictions.

Outside of observations made above, the results reported in table 3-5 indicate that the variables are statistically significant and yield theoretically expected signed coefficients. In particular, an improvement of terms of trade appreciates the rand's real exchange rate. So too do increases of the real interest rate differential, the productivity differential, the stock of foreign reserves, total government expenditure, and net capital inflows. By contrast, increased openness of the trade regime depreciates the rand's real exchange rate, as does an increase of the inflation differential, the stock of foreign debt, and the fiscal deficit.

The results also suggest the terms of trade variable, the productivity differential variable, government expenditure, and net capital flows as factors that have had the major influence on the real effective exchange rate. In respect of the terms of trade variable, real gold price has the most influence on the real effective rate only when evaluated over the entire sample period, from 1972 to 2003. When examined over the

shorter and more recent period from 1985-2003, the influence of the gold price appears to diminish. In this period, the terms trade excluding gold price turns out to have the most influence on the rand's real exchange rate.

Thus, based on the results reported in table 3-5, we make the following broad conclusions about the long run relationships defining the time path for the real exchange rate for the rand:

Real Interest rate differential

- Over the period 1972 to 2003, a 100 basis point increase in the real interest rate differential on the 10 year government bond between South Africa and its major trading partners implied, on average, a real appreciation of at least 4% to 10%. However, this falls to an average 2% over the shorter and more recent period, from 1985 to 2003.

Fiscal position

- A one percentage point increase in the fiscal budget deficit relative to Gross Domestic Product, on average, depreciates the real exchange rate by at least 3% to 4%, and this increases to 7% when the model is examined over the period from 1985 to 2003.
- This contrasts with the impact of total government expenditure, to which the real exchange rate appreciates by an average 9% in response to one percentage point increase. Over the period 1985 to 2003, the influence of total government expenditure rises to as much as 24%, on average.

Terms of trade

- To every percentage in increase in the real price of gold, the rate of appreciation of the real exchange rate ranges from 0.67% to 0.98%, over the entire sample period, but this diminishes over the period 1985-2003 to 0.26%.

- On the other hand, a percentage increase in the terms of trade with gold prices excluded appreciates the real exchange rate by 0.5% to 1.51%.

Labour productivity differential

- A percentage point gain in productivity relative to South Africa's main trading partners appreciates the rand's real exchange rate by about 0.59% to 0.66%. However, this fluctuates between a low of 0.22% and a high of 1.02% when the model is evaluated over the period of 1985 to 2003.

Trade openness

- Increased trade openness by a percentage point relative to Gross Domestic Product is associated with depreciations of the real exchange rate ranging from 2% to 3%, over the entire sample period. However, this falls slightly to 1% to 2% over the period 1985-2003.

Foreign exchange reserves

- An improvement in South Africa's net foreign asset position by one percent of gross domestic product tends, on average, to appreciate the real exchange rate by at least 2% to 4%.
- This improves strongly to at least 4% to 6% when the stock of foreign assets is measured in gross terms.

Inflation differential

- A percentage point increase of the inflation rate differential between South Africa and its major trading partners tended, on average, to be associated with depreciations of the rand's real effective exchange rate of about 1%. However, this variable is only statistically significant at the 10% level of significance; hence the result may not be robust

Table 3-5: Results of estimating co-integrating relationships among the variables (1972q1-2003q4 and 1985q1-2003q4)

Variable description	Model	1B	2A	4A	4C	5B	5C
	Est. period	1972-03	1972-03	1985-03	1985-03	1985-03	1985-03
	Var. name						
Real exchange rate	LREER	1.00	1.00	1.00	1.00	1.00	1.00
Interest rate differential	RGBRDD	-0.07 [-8.39]	-0.04 [-3.09]	-0.02 [-3.70]	0.01 [-2.29]	-0.004 [-1.51]	-0.01 [-4.50]
Fiscal position	FBA	0.03 [3.35]		0.07 [11.38]	0.04 [11.42]		
Terms of trade	GVEPTR		-0.09 [-1.65]			-0.16 [-7.06]	-0.14 [-10.50]
	LGOLPRN	-0.81 [-10.01]	-0.67 [-9.06]	0.00			
	LTOTGN						
	LTOIN				-0.67 [-2.38]	-1.51 [-5.15]	-0.50 [-3.44]
Productivity differential	LGDPKDN	-0.66 [-7.38]	-0.59 [-2.81]	-0.64 [-3.21]	-0.22 [-2.00]	-1.02 [-5.71]	-0.22 [-5.48]
Commercial & trade policy	OPEN	0.03 [7.45]	0.03 [6.73]	0.02 [6.46]	0.01 [8.19]	0.03 [9.34]	0.01 [20.90]
Foreign reserves	NFAMS			-0.04 [-8.40]	-0.02 [-9.09]		
	FXRR	-0.06 [-5.10]	-0.04 [-3.43]			-0.03 [-5.51]	0.00
Inflation differential	INFLRD	0.00	0.01 [1.52]				
Foreign debt	FXBTR	0.00	0.00	0.03 [1.79]	0.03 [3.02]		
Capital flows	NTFDI			-0.11 [-5.18]	-0.08 [-6.17]	-0.11 [-6.16]	
	NFDIN						-0.06 [-9.29]
Constant	C	-5.19	-4.90	-5.32	-5.11	-4.61	-4.12
Tests for Coeff restrictions							
Chi-SQ statistic		3.53	1.49	0.14			2.51
(P-value)		(0.17)	(0.22)	(0.71)			(0.11)
[number of restrictions]		[2]	[1]	[1]			[1]
Error correction term -CointEq1		0.00	-0.07	-0.10	-0.13	-0.79	-0.68
Half life of deviation from equilibrium (years)		[0.00]	[-0.98]	[-0.68]	[-0.55]	[-3.71]	[-3.62]
		0.00	2.4	1.6	1.2	0.1	0.2

3.2.4.3 *The rand's long run equilibrium real exchange rate and misalignment*

Having established a long run relationship of the rand's real exchange rate with its fundamental determinants, we used the parameters obtained in that relationship to estimate an equilibrium real exchange rate measure for the rand, which we also used to calculate the degree of misalignment. As noted earlier, this is a measure of the real exchange rate when the fundamental determinants are themselves at their sustainable levels. The fundamental difficult, however, is that the sustainable values are largely unobservable. In practice, one observes values for fundamental determinants that are likely to incorporate both transitory and permanent components. However, when variables are non stationary, as is the case at hand, the permanent component can be approximated by the variable's underlying stochastic trend, on the ground that movements generated by a unit root are permanent (Baffles et al, 1999). One common practice in the literature is, therefore, to apply smoothing techniques to the data to discern a variable's permanent component, which is used to proxy its sustainable value.

We followed this practice in the literature. For our applications, we used the Hodrick-Prescott H-P filter, which is a data smoothing method commonly used to remove short-term fluctuations in a data series, thereby revealing its underlying long term trend. We used the series generated in this manner to construct F_t^p , the permanent component of each of the observed fundamental determinants F_t . The equilibrium real exchange rate is then given by the expression below as

$$\bar{q}_t = \hat{\beta}' F_t^p \quad (10)$$

Where $\hat{\beta}$ denotes the vector of estimated long run coefficients.

The estimated degree of real exchange rate misalignment, which we labelled m_s , is simply the percentage difference between the observed value for the real exchange

and its computed equilibrium value obtained using the above formula. We may express this by the following expression.

$$m_s = (q_t - \bar{q}_t) * 100 \quad (11)$$

In figures 3.2 to 3.7, we report for each model examined results from comparing observed values for the rand's real exchange rate to its estimated equilibrium value, along with corresponding degrees of misalignments obtained using the above formula. According to figures 3.2 and 3.3, from 1994 to 1996, and also in 1998, the rand's real exchange rate became undervalued (more depreciated relative to its equilibrium value) by an average 10%, but remained more or less in line with its equilibrium value during 1997 as well as the period from 1999 to 2000. Also, it appears the rand crisis of 2001 caused a 20% undervaluation of the real exchange rate by the end of that year. In contrast, the subsequent strong recovery of the rand at the start of 2002 may have pushed the real exchange rate 17% above its equilibrium value by the end of 2003, thereby suggesting a loss of trade competitiveness of a similar magnitude.

Likewise, figures 3.4 to 3.7 point to an average 16% real overvaluation of the rand in the last quarter of 2003. However, in this case, the size of overshooting in the period 1993-1996 and 1998 is moderated somewhat due to the diminished impact of the real interest rate differential given by the underlying model. In consequence, we reach the result that, in the absence of substantial declines in domestic prices, the average exchange rate of 8 rand per US dollar that prevailed at the end of 2003 entailed considerable loss of trade competitiveness for South Africa, and as such, needed a depreciation of the rand's nominal exchange rate to correct the imbalance.

Figure 3-2: Real exchange rates of the rand (model 1B)

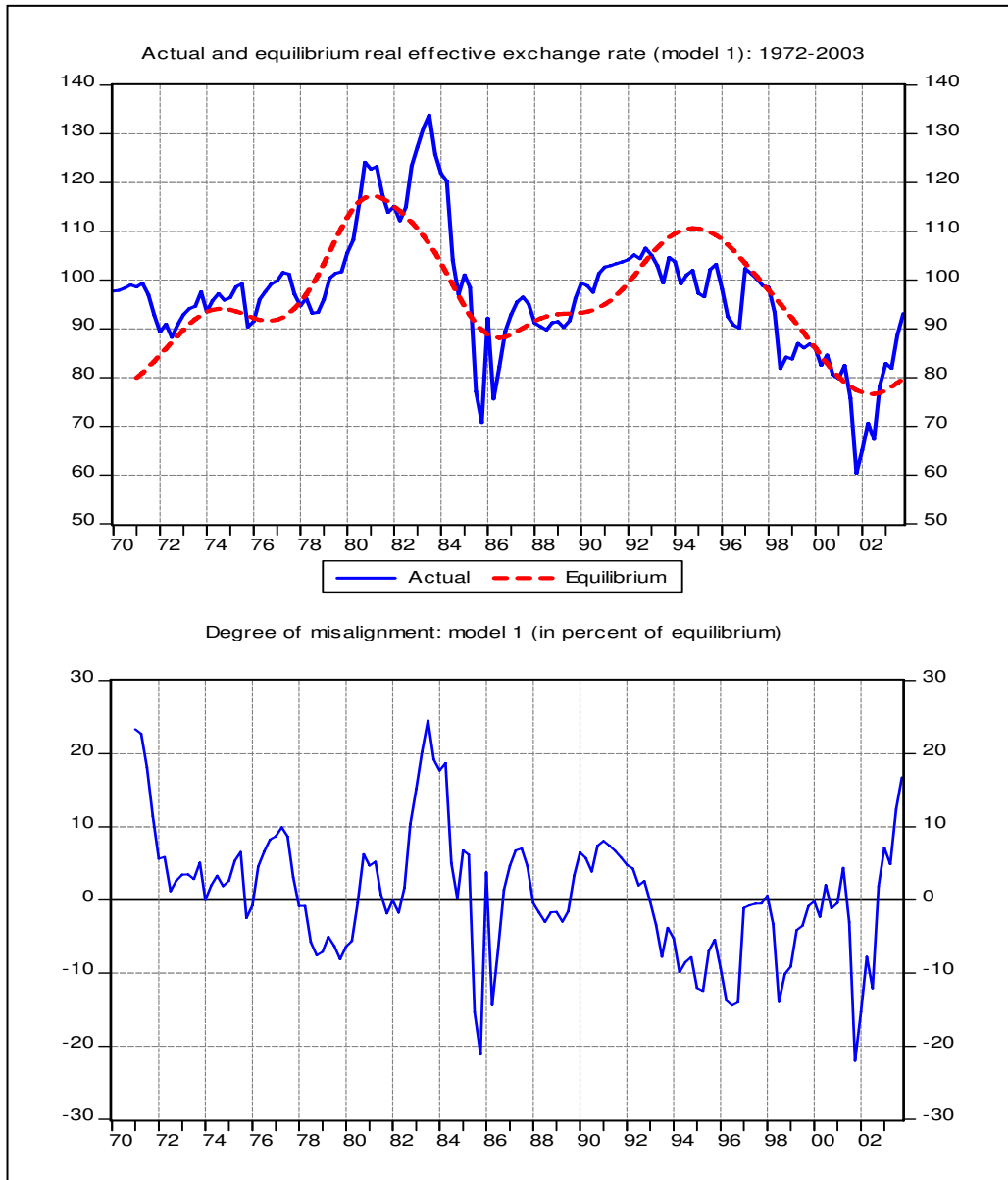


Figure 3-3: Real exchange rates of the rand (model 2A): 1972-2003

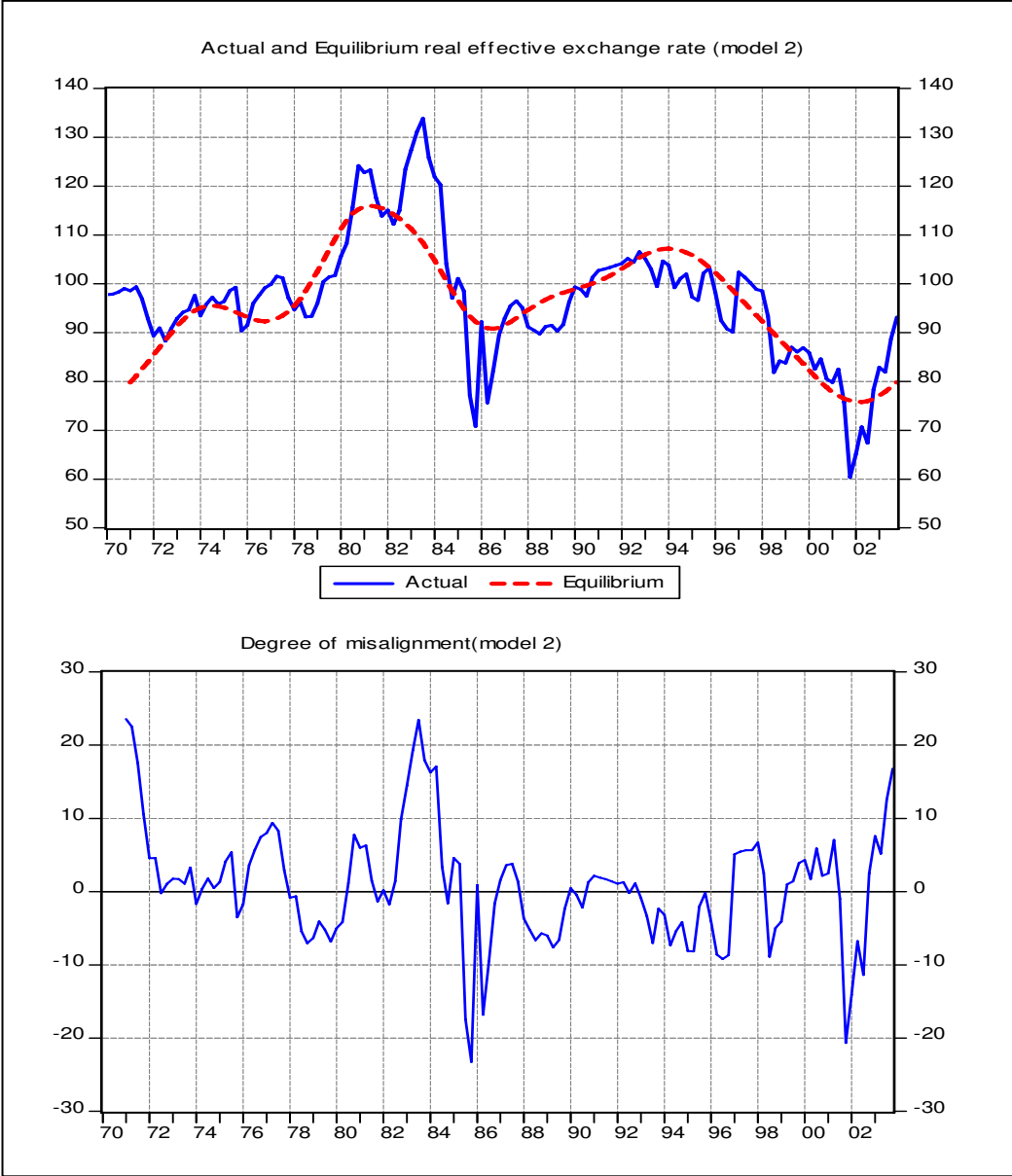


Figure 3-4: Real exchange rates of the rand (model 4A): 1985-2003

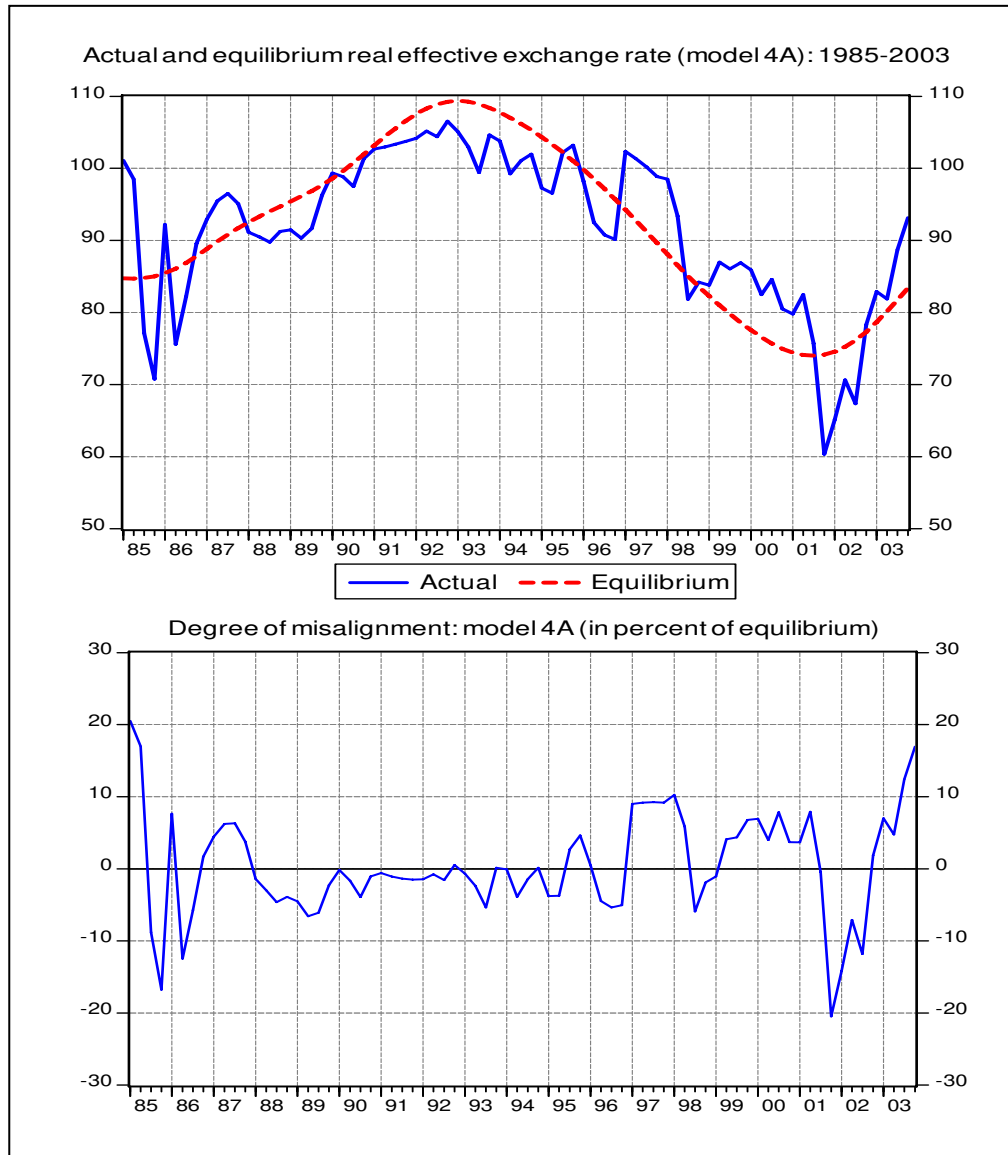


Figure 3-5: Real exchange rates of the rand (model 4C): 1985-2003

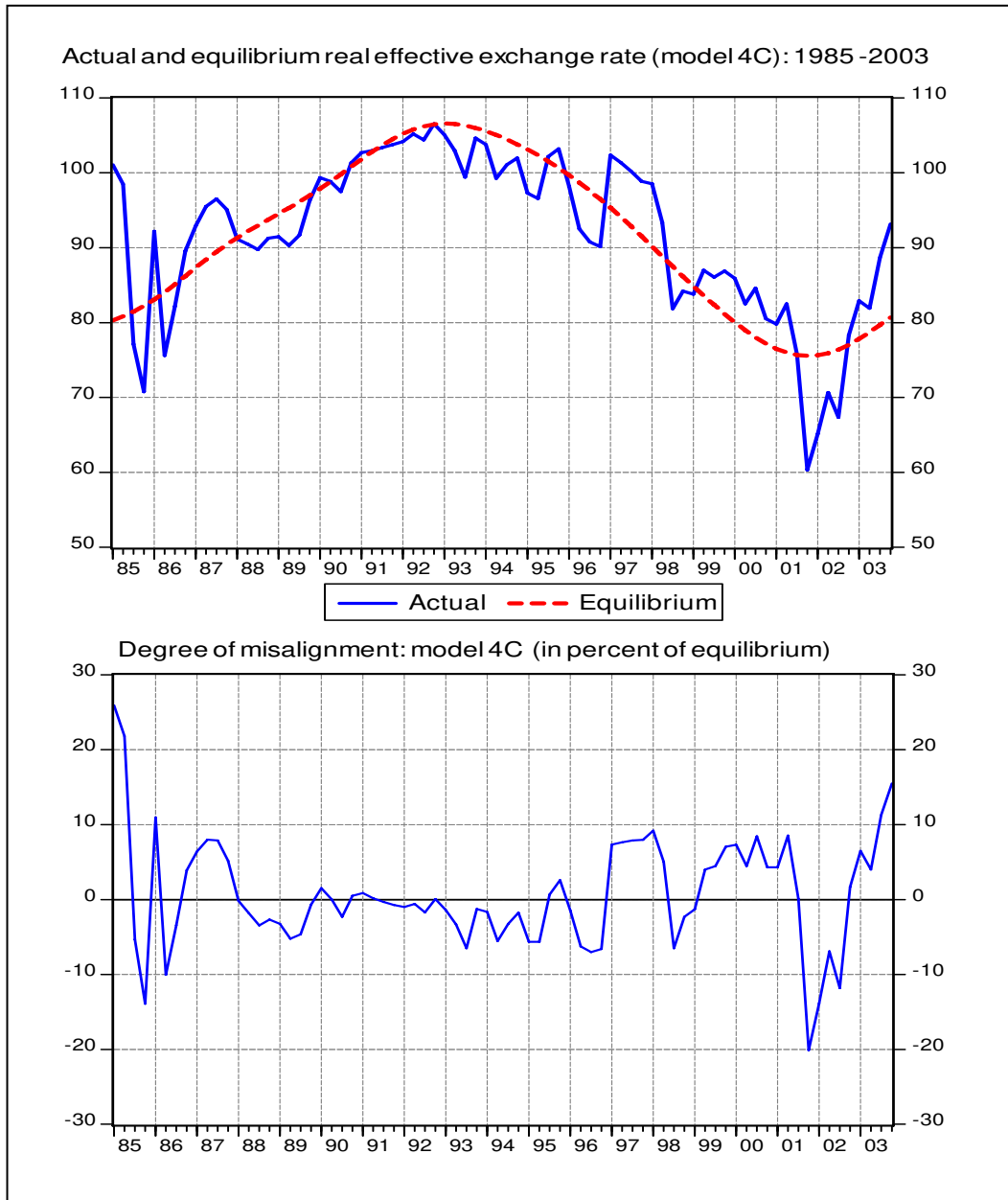


Figure 3-6: Real exchange rates of the rand (model 5B): 1985-2003

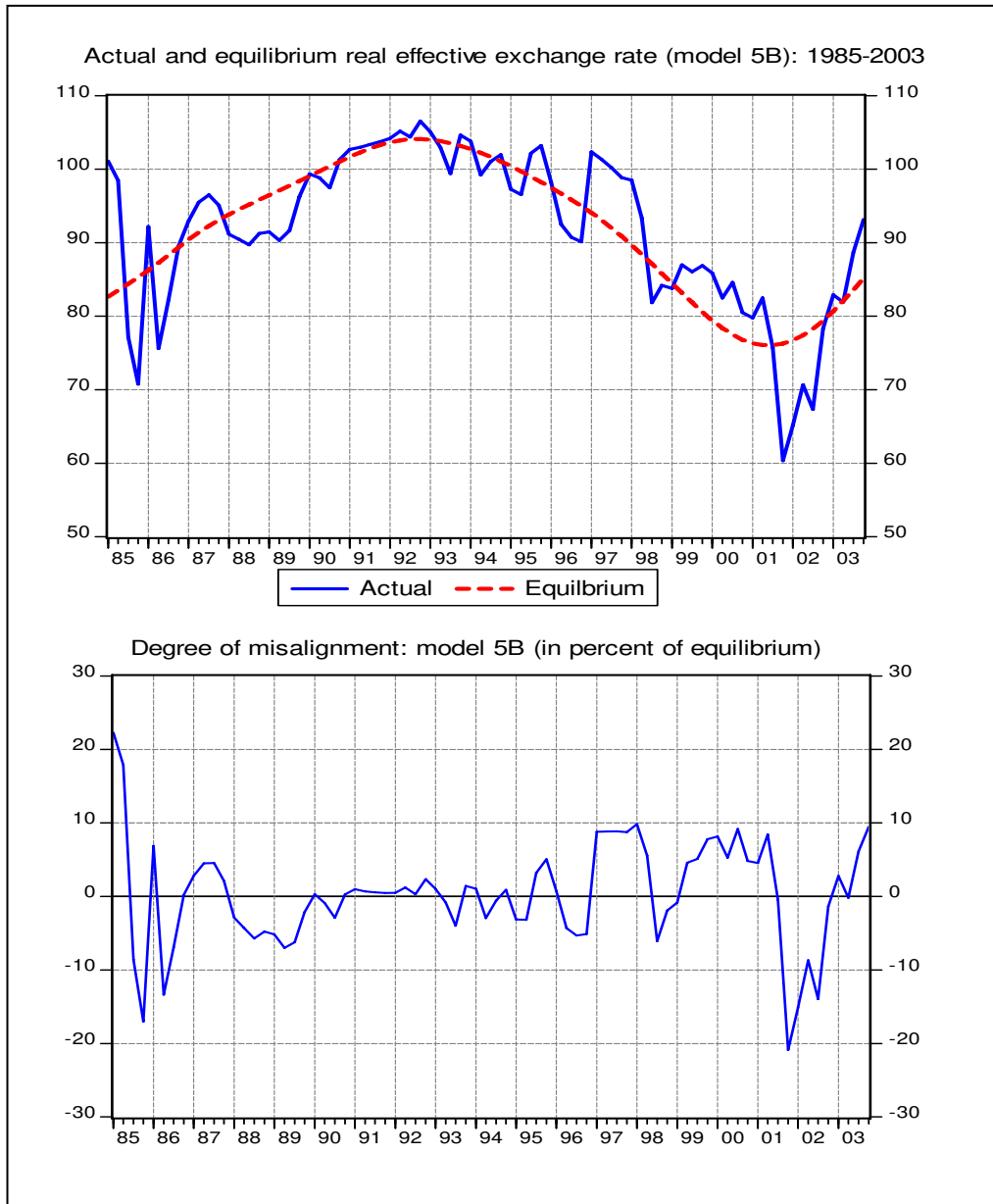
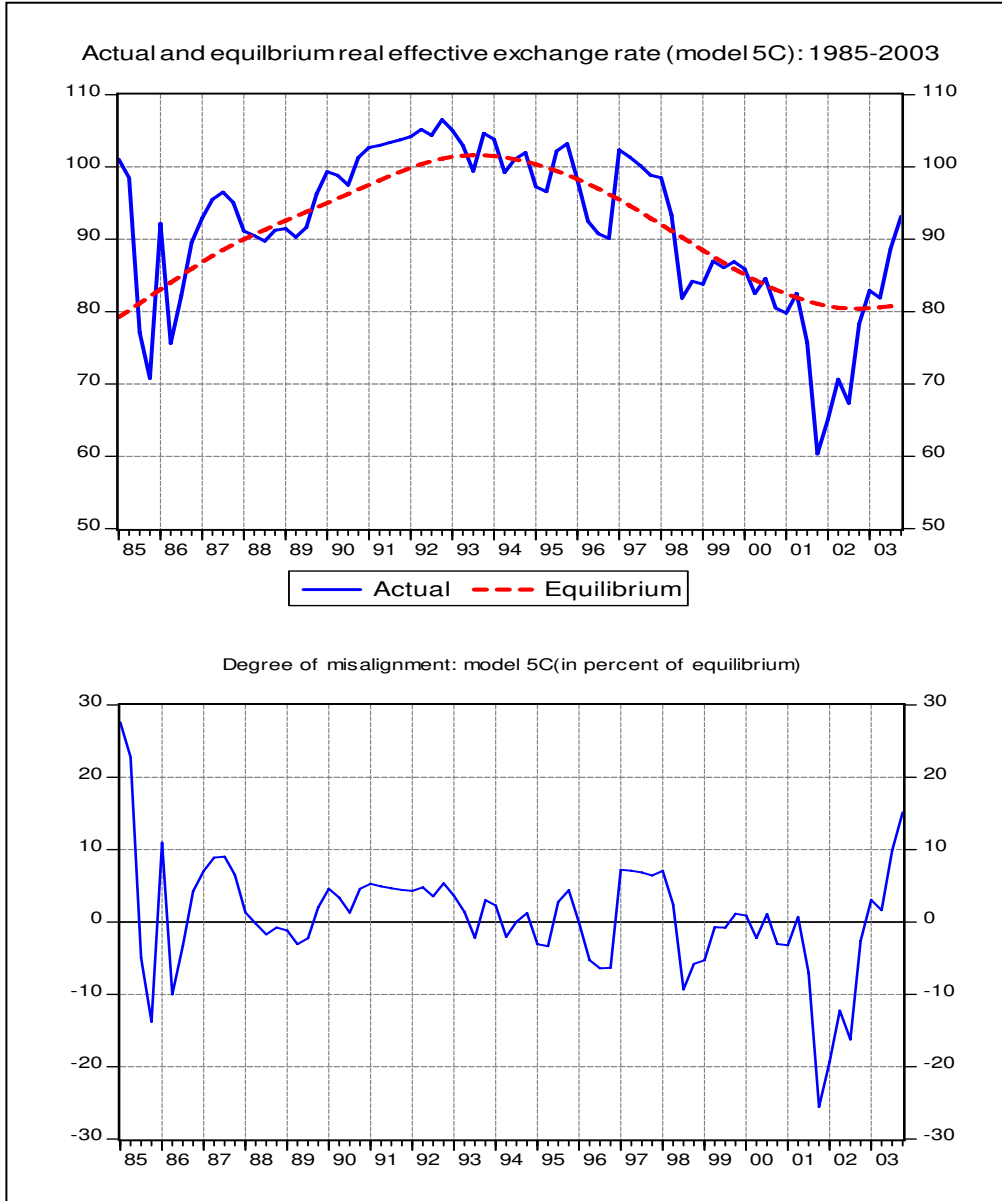


Figure 3-7: Real exchange rate of the rand (model 5C): 1985-2003



4 Conclusion

Since South Africa's transformation to a democracy in 1994, volatility of the rand's real exchange rate has heightened. This increase in volatility of the real exchange rate presents the concern that the rand may have been misaligned; and thereby undermines competitiveness of South Africa's production on the international markets. Because an overvalued rand increases the price of domestic goods abroad, it could generate lost output by reducing profits and employment in some export and import competing industries. Given that foreign trade has been fundamental to the growth of the South African economy, the issue of trade competitiveness is therefore a pertinent one. Efforts by the Government to address current high levels of unemployment and widespread poverty among most of the population have depended on achieving sustained growth of the economy.

Our aim in this study has been to assess the extent to which recent fluctuations of the rand's real exchange rate signify misalignment in the currency, thereby affecting competitiveness of South Africa's goods abroad. As misalignment is assessed with reference to benchmark long run equilibrium value, we sought to determine this issue by first investigating the extent to which observable changes in the real exchange rate are explainable based on fundamental determinants. We established that, in the long run, the rand's real exchange rate appreciates in response to changes in the differences in real interest rates and labour productivities relative to those prevailing in the major trading partner countries. Accumulation of foreign reserves, increased fiscal expenditures, improvement in the terms of trade, and inflows of capital also appreciate the real exchange rate. On the other hand, changes in the size of the fiscal deficit, increased openness of the trade regime, and accumulation of foreign debt cause the rand's real exchange rate to depreciate in the long run.

These findings then permitted calculation of an equilibrium value for the rand's real exchange rate, which we used as a point of reference to distinguish and assess the degree of real exchange rate misalignment and the implication of this for export

competitiveness. This revealed that, from 1993 to 1996, and also in 1998, the rand's real exchange rate had overshoot its equilibrium value by an average 10%, while the 2001 rand crisis had brought about a 20% undervaluation of the rand at the start of 2002. Conversely, the strong appreciation of the rand, which began in early 2002, had, by the last quarter of 2003, culminated into an average 15% overvaluation of the rand real exchange rate. In consequence, South Africa's exports remained at a competitive disadvantage during 2003.

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